FARM FACTS

Best Management Practices when harvesting surplus cereal straw

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Key points when considering harvesting surplus cereal straw:

- ***Maintain sufficient crop residue on the land to protect the soil from erosion. This can be accomplished by keeping the stubble standing especially after seeding.***
- ***Harvest surplus crop residue with an appropriate frequency so as to not lower soil organic matter, soil fertility and crop productivity.***
- ***Fertilize crops according to soil test recommendations.***

Determining the inherent value of wheat straw

The decision and the amount of straw to be removed should be based on the inherent value of the straw for maintaining the viability of the cropping system and protecting the soil resource versus the value of the straw for other uses (e.g., feed and bedding for livestock, industrial strawboard, feedstock for alternative energy forms). The value of retaining the straw on the land is difficult to determine but should be based on a number of factors such as:

- ***value of straw for soil erosion control***
- ***equivalent fertilizer value of the nutrients contained within the straw***
- ***value of the straw for building soil organic matter, soil quality, and soil tilth***
- ***value of the straw for soil moisture conservation.***

If the value of the straw for the above factors exceeds its market value in other uses then some or all of the straw should be retained on the land. The following pages provide a discussion of factors to consider when determining the inherent value of straw.

Stubble height and residue amount required for erosion control

- **Tall stubble provides greater protection against wind and water erosion and improves soil moisture conservation through trapping snow and reducing evaporation losses**. Tall stubble also helps maintain the surface soil in a moist state, which improves seedbed conditions for shallow seeded crops. Therefore, stubble should be cut as tall as possible without causing problems with plugging of seeding equipment.

  Generally the stubble height can be similar to the row spacing of the seeder or cultivator. Most air-seeders have row spacing of eight to 12 inches, so stubble height can generally be from eight to 12 inches. With direct seeding equipment that has four ranks of knife openers, some growers successfully manage stubble heights up to 1.5 times the row spacing. Newer direct seeding equipment with coulter or disc openers are able to handle taller stubble with few plugging problems. In most years, shallower seeding results in less soil disturbance and better and more uniform crop emergence.

- **Slower speeds during seeding disturbs less soil and buries less residue**.

- **Anchored, standing residue is much more effective for erosion control as compared to loose, unanchored residue.** A 40 bu/a wheat crop leaves about 750 lb/a of 6-inch tall standing stubble.

- The amount of crop residue required for control of wind and water erosion varies with field slope, soil texture, residue type, weather conditions, soil aggregation (clodiness), and tillage practices. Saskatchewan Agriculture and Food recommends a general guideline of 750 lb/a of standing stubble plus 250 lb/a of loose residue be retained on the soil surface after seeding operations are completed. This applies to well-aggregated loam soils. Increasing amounts of residues must be retained to prevent erosion on more sensitive soils.

  Where surplus straw is harvested, direct seeding practices provide the best opportunity to maintain sufficient residue to protect the soil. To consistently maintain adequate residues zero-till management practices are required.

- A survey of 4,500 fields across Saskatchewan found that 62 per cent of the fields had less than 500 lb/a of residue cover after seeding, in the spring of 1998. Only six per cent of the fields had standing stubble after seeding which offers the best protection against erosion.

- A wheat crop yielding 20 to 23 bu/a under average fertility and growing conditions will provide enough residue for adequate protection of the soil from wind erosion if low disturbance direct seeding (zero-till) is practiced. This assumes about 15 per cent of the residue (leaves and chaff) is decomposed over winter and 10 per cent of the residue is buried during the zero-till seeding operation. However, the straw to grain ratio of wheat is quite variable, so in some years a producer may bale some straw from his 20 to 23 bu/a wheat crop, while in other years he cannot. Careful consideration of all the factors is required before straw is removed. (See section "Determining the Inherent Value of Wheat Straw" above.)

When to avoid harvesting straw

- Land with significant slope should not have the straw harvested because of its vulnerability to soil loss by water erosion.
- Sandy textured soils are also at high risk to erosion and should not have the straw harvested, especially in the Brown and Dark Brown soil zones.
- Straw should not be harvested from eroded knolls. It is needed in these areas to protect the soil and to build soil organic matter.
- Straw from canola, mustard or pulse crops should not be removed. Some of these crops will produce as much straw as wheat, but the residues disappear from the soil surface more rapidly, and are less effective for controlling erosion.

Shelterbelts/barrier strips and strip cropping

- Use of tree shelterbelts and barrier strips (perennial grass or annual barriers) are encouraged in drier areas and on vulnerable soils.
- Strip cropping is also an effective means of controlling soil erosion in drought-prone areas.

Crop rotation

- If straw is harvested from land that requires added erosion protection, consider planting winter cereals such as fall rye or winter wheat. This will provide continuous cover especially during spring months when the land is most vulnerable to erosion.
- Straw should not be harvested from fields that are to be summer-fallowed. If straw has been harvested from these fields, chemicals (versus tillage) should be used to control weed growth.

Straw to grain ratio and amount of straw that can be baled (harvested)

- The ratio of total residue (straw plus stubble plus chaff) to grain for a wheat crop is typically 1.66 (1.66 lbs of residue per lb of wheat (grain) harvested). However this ratio varies widely depending on growing conditions, fertility, wheat class and crop variety. The ratio can be as low as one lb of residue per lb of grain, to as high as four lbs of residue per lb of grain.
- Generally, the quantity of straw that can be removed by baling ranges from 0.6 to 0.8 lb for every lb of grain. Besides the standing stubble that is left behind, balers often do not collect chaff and small pieces of straw that fall to the ground. Rotary combines may produce less baleable straw than conventional combines especially under dry conditions. Chaff spreading during the combining operation is required.

Selecting a variety

- Select varieties of wheat with tall straw to allow for the desired stubble height and for some surplus straw for baling. For example, AC Barrie is a tall variety with high yield potential. Semidwarf varieties produce shorter and less baleable straw and may be less desirable for straw harvesting.

Frequency for harvesting straw

Crop residue is essential to build and maintain soil organic matter. If straw is removed too frequently, soil organic matter levels will decline and productivity and tilth of the soil will be reduced.

- The harvesting of surplus straw must be planned for within a rotation cropping system and it is generally recommended that straw be harvested at a frequency of no more than once in four years.
- A 40-year crop rotation experiment at the Indian Head Research Farm has shown that a properly fertilized fallow-wheat-wheat rotation can maintain crop yields and soil organic matter even when the straw is baled after each wheat crop. The removed straw represented about 40 per cent of the total residue produced, and in this case, the roots and residue that is left behind was sufficient to maintain soil organic matter. The only soil factor affected by straw harvesting was soil aggregate size, which was slightly reduced when the straw was harvested.

These plots were converted to zero-till management in 1990, and between 1987 and 1997 there was an increase in soil organic matter, despite having harvested the straw.

- A 13-year study conducted in the Thick Black and Gray soil zones of Alberta determined the effects of removing all of the above-ground crop residue.

  When fertilizer was added according to soil test recommendations, soil organic matter increased over time even in plots where all crop residue was removed.

  Retuning the straw, fertilizing to soil testing recommendations and eliminating tillage had the greatest effect on increasing soil organic matter.

  There was little effect on soil organic matter in the unfertilized plots.

- It is difficult to make a general recommendation on how often a portion of the straw can be safely harvested from a particular field. In soils with low initial soil organic matter (Brown and Gray soil zones), a frequency of once every five to seven years may be acceptable. In a well fertilized continuous cropping system in the Black soil zone, surplus straw may be baled each year that a cereal crop is grown, providing the chaff is spread and the remaining stubble is left anchored to protect the soil from erosion.

Fertilizer use and application

- Soil testing and subsoil moisture sampling are valuable tools to ensure optimum grain and straw yields. A cereal crop fertilized to soil test recommendations will produce more straw and grain than an unfertilized crop.

- Where possible, fertilizer should be banded during the one-pass seeding operation. Low disturbance sidebanding openers also allow for fertilizer banding at the time of seeding, while coulter and disc applicators can be used to sideband or mid-row band fertilizer during the seeding operation, or as a separate operation.

Nutrient content of wheat straw

The generally accepted levels of nutrients removed by crops and their residues under good growing conditions is published in the Canadian Fertilizer Institute fact sheet "Nutrient Uptake and Removal by Field Crops, Western Canada 1998", Table 1.

A Saskatchewan Agriculture and Food initiated study of the nutrient content of Saskatchewan wheat straw under farm conditions for the 1998 and 1999 crops found average nutrient levels in agreement with the industry fact sheet. The values in the Canadian Fertilizer Institute fact sheet represent the total nutrients at maturity and is intended as a general estimate of the nutrients used by crops. However, there is considerable variability in nutrient uptake among wheat classes and varieties. Other factors that influence nutrient levels of straw and lead to wide variation in the nutrient levels from field to field are: fertilizer practices (amount and balance of nutrients), weathering of the straw after maturity and before baling, and soil and climatic conditions.

Nutrient content of wheat straw from Table 1 expressed as a percent by weight is as follows: N (0.55 – 0.68%); P_2O_5 (0.20 – 0.23%); K_2O (1.23 – 1.5%); S (0.10 – 0.13%).

From the nutrient levels in Table 1, one tonne of wheat straw has the following levels of nutrients given a 1.66 straw to grain ratio: N (12 – 15 lb); P_2O_5 (4.5 – 5 lb); K_2O (27 – 34 lb); S(2 – 3 lb).

If the nutrient content of straw is in question then a representative sample should be collected and submitted for analysis to a soil testing laboratory. Also, pre-feasibility studies should include determining nutrient levels of baled straw by crop type and harvesting method from the procurement area for the proposed processing plant due to the wide variation of nutrient levels in straw.

Calculating the fertilizer equivalent value of the nutrients in the straw (Table 2)

- To determine the present market value for each fertilizer nutrient use the fertilizer prices in your area. In this example assume:
  - Nitrogen-N sells for $0.27/lb N,
  - Phosphate (P_2O_5) sells for $0.35/lb P_2O_5,
  - Potassium (K_2O) sells for $0.15/lb K_2O, and
  - Sulphur (sulphate form) sells for $0.28/lb S.

Table 1. Average nutrient uptake and removal by a 40 bu/a wheat crop with a straw to grain ratio of 1.66 under western Canada conditions.

Grain		N (lb/a)	P_2O_5 (lb/a)	K_2O (lb/a)	S (lb/a)
Spring wheat	Total uptake	76 – 93	29 - 35	65 - 80	8 -10
40 bu/a producing	grain	54 – 66	21 - 26	16 -19	4 - 5
3984 lb/a of straw	straw	22 – 27	8 - 9	49 - 61	4 – 5

* Source. Nutrient Uptake and Removal by Field Crops, Western Canada 1998. Canadian Fertilizer Institute.

Table 2. Nutrient content and value of nutrients in one tonne of wheat straw*

Nutrient (lb/tonne)	Price of the fertilizer nutrient ($/lb)	Value of nutrient ($/tonne)
N (12 – 15)	0.27	3.24 – 4.05
P_2O_5 (4.5 – 5)	0.35	1.58 – 1.75
K_2O (27 – 34)	0.15	4.05 – 5.10
S (2 – 3)	0.28	0.56 – 0.84
Total		9.34 – 11.74

* Values have been rounded. Nutrients contained in agriculture residues may be exposed to increased losses as compared to chemical fertilizer nutrients.

Note: Most Saskatchewan soils are high in potassium. Fields should be soil tested on a regular basis to monitor the change in available-potassium levels and other nutrients because of the extra nutrients being removed by harvesting the straw. For more information on potassium and other nutrients refer to the Saskatchewan Agriculture and Food Farm Facts available at Rural Service Centres and at www.agr.gov.sk.ca.

Greenhouse Gases and Carbon sequestration

- When crops grow, they remove carbon dioxide from the air. The carbon in carbon dioxide is used in all plants parts. A portion of the carbon taken up by the plants is returned to the soil as residues. When these crop residues decompose they release carbon dioxide back to the air, but a small amount of the residue carbon becomes tied up in soil organic matter. Carbon dioxide is a major greenhouse gas and so there is interest in determining to what extent this natural process can be used to reduce carbon dioxide concentrations in the air. If we can increase organic matter in our soils, it represents atmospheric carbon that is now sequestered (or fixed) as soil organic matter.

  Research has shown that soil organic matter can be built up by: fertilizing to soil test recommendations, increasing cropping intensity, reducing the amount of summerfallow, and reducing the amount of tillage used.

  The value of these soil organic matter increases (or carbon sinks) is being debated as part of an international effort to reduce greenhouse gas emissions (Kyoto Agreement on Greenhouse Gases Reductions).

- Straw can be used for manufacturing strawboard. The carbon in the straw that makes up the strawboard will not decompose and thus will not be released back to the air as carbon dioxide during the life of the product. (e.g., furniture or house). Storing carbon in strawboard is a form of carbon sequestration. This can be extended by further recycling the straw-based products.

- There is also growing interest in using straw as a feedstock to make fuels, such as ethanol, which could replace fossil fuels. When fuels made from straw are burned, the carbon in the fuel is released back to the atmosphere as carbon dioxide. However, since the carbon dioxide was initially removed from the air by the crop, there is no net addition of carbon dioxide into the atmosphere.

More information:

- *Direct Seeding Manual – A Farming System for the New Millennium, 1999.* Prairie Agricultural Machinery Institute, Humboldt, Saskatchewan. Call 1-800-567-7264.

- *Securing Acceptable Erosion Risks after Pulses and Oilseeds in the Brown and Dark Brown Soil Zones.* Semiarid Prairie Agricultural Research Centre, Saskatchewan Agriculture and Food.

- Saskatchewan Agriculture and Food web site: www.agr.gov.sk.ca

- *Nutrient Uptake and Removal by Field Crops – Western Canada 1998.* Contact Saskatchewan Agriculture and Food, Rural Service Centres or www.cfi.ca

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